NORTH (N.L.)

A

THEORY OF INFLAMMATION.

ITS CAUSE, COURSE,

AND

RATIONALE OF TREATMENT.

By NELSON L. NORTH, M.D.,

SURGEON METROPOLITAN POLICE; CONSULTING SURGEON TO WILLIAMSBURGH DISPENSARY; MEMBER OF THE AMERICAN MEDICAL ASSOCIATION, ETC.

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AN INAUGURAL THESIS

UPON THE

PHENOMENA AND PROXIMATE CAUSE

OF

INFLAMMATION.

WITH AN ALLUSION TO THE TREATMENT, AND TO THOSE DISEASES WHICH APPROXIMATE OR ASSUME THE INFLAMMATORY CONDITION.

Submitted to the Public Examination of the Trustees and Faculty of the College of Physicians and Surgeons of the University of the State of New York, Alexander H. Stevens, M.D., LL.D., President.

For the Degree of Doctor in Medicine.

March 12th, 1854.

By NELSON L. NORTH,

OF THE STATE OF NEW YORK.

To

WILLIAM BUDD GOULD, M.D.,

GRATEFUL FOR HIS TEACHING, AND MANY ACTS OF KINDNESS, AND HAPPY IN BELIEVING HIM A FRIEND,

I Dedicate this Essay, with respect and esteem.

N. L. NORTH.

INFLAMMATION:

ITS PHENOMENA, PROXIMATE CAUSE, ETC.

I AM aware that the "scientific" look upon *speculations* and *theories* with a *great deal* of *distrust*. "*Facts*, gentlemen, *facts*," say they; "let us look at the *facts*."

"Your *theorizing* will never do."

"Analogical reasoning amounts to '*mighty little*' in physiology or pathology."

"He who *knows least* can *theorize most*."

In the face of such remarks as these, which I hear almost every day, and can in nowise dispute, but rather confirm in my own mind, *I* have concluded to "*theorize*" upon the important subject which I have chosen. And I intend to write as if I knew all about this complicated and disputed subject, delineate my views *fearlessly*—whether sustained by "*authorities*" or not—sustain them as best I can, and if I am entirely wrong upon a subject which has led so many astray, I shall only be one among the many. But if so be that I have something of the *right*, and should this attempt lead others—abler and better informed—to *investigate* what I attempt to express here, and thereby develop something practicable and useful, then I shall have written a thesis for a purpose—something other than a mere stepping-stone to *graduation*—and then, perhaps, it may not fall into the "archives of the college" with but *one* passing look and a consideration of its entire worthlessness, except to help another half-thinking mortal into a profession second to none upon earth.

By inflammation I mean that peculiar morbid action of the animal economy, accompanied by tumefaction, redness, increased heat, and *pain*. It may be arranged in three general divisions or stages, viz. irritative, formative, and resulting. These, of course, admit of many subdivisions.

The *irritative*, or first stage, takes place through the medium of the *nerves* extending their influence to the capillary blood-vessels, and is caused by anything which disturbs them (the nerves), either whether it *weaken* to a certain extent, and thus irritate, or whether it strengthen beyond normal so as to produce strong action, or whether it unduly act upon the normal excitability. In either case, the nervous system is on the *qui vive*, so to speak, and there is a general action of the minute nerve ramifications of the part, affecting, either directly or by reflex action, the muscular fibres of the minute or capillary blood-vessels, arousing them to action, causing what is commonly noticed as the first phenomena of inflammation, viz. "a change in the condition of the blood-vessels." This change is first a contraction and then an *opening* of the capillaries. At times, when the irritation is severe, the contraction is not noticed, but the *opening* (or enlargement both of calibre and diameter of the vessels) is apparently the immediate result of the irritation; and here, according to my division, we have the commencement of the second, or *formative stage.*

This *opening* of the capillaries forms, in the tissues affected, a kind of *spongy mass*—analogous to "spongy platinum"—which inherently absorbs gases, perhaps more especially oxygen, atmospheric air, etc. And as the blood, by its attraction, it may be—for the oxygen, and by its tendency to fill the partial vacuums that have been formed by the enlargement of the vessels, rushes to the point affected, it not only becomes "purified," as is usual in the lungs, but *other* changes take place, chemical in their nature, as perhaps a portion of the albumen being brought in close contact with the excess of oxygen *combines* with a portion of the latter, forming *fibrin* in greater or less quantities, according to the activity of the inflammation, condition of the system, etc., together with other changes hereafter to be mentioned; and thus are developed

the usual phenomena of pain, redness, heat, and swelling. This stage and state of things do not necessarily follow the *irritation* if properly treated, or in all cases, if not treated at all. But we *have* at this point the "*active congestion*," and the next stage is *sure* to follow (except arrested by bold treatment).

Of "*passive congestion*" I shall speak hereafter, if time and space permit.

In the *third* and last division, the *resulting stage*, we have the usual phenomena attributed to the disease, as effusion, formation of false membrane, suppuration, ulceration, and granulation, with the terminations in "resolution, adhesion, cicatrization, and death."

The first, or irritative stage, then, is wholly nervous, *and is produced* by anything which excites *a certain amount of action* in the smaller nerve fibres,* and *continues* that action for any great length of time. Thus cold excites the nervous system, as we are never more sensitive than when chilled, knocks and bruises are much more painful when the parts receiving them are *cold* than when naturally warm. (When carried to the extent of freezing, however, this effect is the opposite.) All kinds of wounds and external injuries, we know, become sensitive and irritable before being much inflamed, although when the injury is severe and the irritation very great, the formative stage follows in a comparatively short time. We know, too, that if the nervous system is overpowered by shock or otherwise, death takes place without irritation, and, consequently, without inflammation.

Most authorities, I believe, allow that primarily the nerves are more or less affected in inflammation. The great John Hunter, so far as I know, invariably admits this as a *fact*, though he does not especially state it as such in the relation in which I use it. He says (in his work on the Blood, Inflammation, etc., page 307), that "inflammation in most cases appears to begin at a point," etc.; and then, "This is so much the case that inflammation shall come at once in a fixed point, giving great

* Perhaps in the fibres of the great sympathetic nerve.

pain, and which shall be *followed* by tumefaction," etc. Then, speaking of the spreading of the disease from that fixed point, he says: "This spreading of the inflammation is owing to continued *sympathy*, the surrounding parts *sympathizing* with the point of *irritation.*" The sympathy and irritation are, of course, actions or conditions of the *nervous* system; and the every remark, of the substantial authority quoted, touching this part of the subject, carries the idea that the first action when the inflammatory state is approaching is nervous. To be sure, he looks upon it more as a premonitory of inflammation than as part of the disease. Speaking upon this point he says (*Ib.* page 308): "The act of inflammation would appear to be an increased action of the vessels;" and going on, "but whatever action it is, it takes place most probably in the smaller vessels, for it may be confined almost to a point where nothing but the smallest vessels exist." This last would go to show that it might be, as I said, an irritation in the smaller nerves, affecting the smaller arteries, as spoken of in what I call the second stage. Mr. Hunter does not consider inflammation as having commenced until after the enlargement of the vessels which produce the "inflammatory blush," as (*Ib.* page 308) he says: "This appearance I shall term a blush; for, although this may be reckoned the first act of inflammation, yet I would not call it inflammation; having produced its lasting effect, I should rather say that inflammation sets out from this point," etc., etc.

Prof. W. Parker (in his lectures at the College of Physicians and Surgeons*) talks long and *strong* upon irritation and inflammation—speaks of the former as preceding the latter, and often running into it, urges the necessity of a diagnosis between the two, as he says, *different* diseases, but which I believe are *different stages* of the *same* disease.

Though the irritation, if treated properly, does not necessarily run into *developed* inflammation, nor is it nearly as apt to in some conditions of the system, or some parts of the body as

* The above, as well as other quotations from the Lectures of the professors of the College of Physicians and Surgeons, were taken as notes during the years 1852, '53, and '54.

in others. Prof. Parker further says, as follows: "I speak first of *irritation*, because the *very first change* from a physiological state is *irritation*." Again: "The *nerves* are the *agents* of this irritation." Again: "If you get disease you get it through the *nerves*, even when you *breathe a bad atmosphere;* (mark) *or if the blood is contaminated, still it is through the nerves that the system is affected.*" Again: "The *nerves undergo a change in inflammation:* they are *enlarged* and in a state of *erection*." Also in his lectures, he referred to inflammation of the eye; said that there was an opportunity to see that there was *first* an irritation, *then* a congestion, and *then* inflammation.*

Although many good authorities admit and uphold the idea of inflammation being preceded by irritation, M. Magendie and his proselytes deny such a condition *in toto*, and even ridicule the idea. He, Magendie, when speaking of this (published lecture, page 266), said: "But such absurd and contradictory ideas as these, I rejoice to see beginning to sink into merited contempt." He attributes the cause to a disturbed capillary circulation. I admit it to be the cause of some of the more prominent symptoms. He says the nerves have *nothing to do in* disturbing that circulation, and attempts to prove this by showing that the disturbance may be the effect of mechanical obstruction, or contraction, or rupture of the capillary. He speaks of the experiments of pricking a vessel with a pin, and of applying caustic, but says nothing about inflammations springing up without any known cause (save that which will affect the nerves).

I am willing to admit (as it is a fact) that caustics and the like applied to the capillaries, or rupture of the vessels, or other such means, may produce a *disturbance* of the capillaries similar to the inflammatory disturbance, or they may even produce inflammation *bonâ fide*, yet I, at the same time, believe that it is, in the first place, an action *like* inflammation, and afterwards *true* inflammation extending around, from the *cause* producing the *irritation* talked of.

Magendie says† (published lectures on Blood, Inflammation,

* See Appendix—Note A.

† Having reference to the movement of the globules, etc.

etc., p. 266), "When one chances to prick a capillary vessel of the mesentery, the blood escapes by the opening, and the globules of the neighboring tube rush to the orifice produced, no matter what the direction of their previous course—(strange). If, on the contrary, the point of your instrument simply enters the tissue of the membrane without injuring any of its capillaries, the circulation continues as before, no abnormal movements of the globules are produced. These results (he says) merit serious examination. What! inflammation depends, you allege, on the exaltation of the vitality of a part—(I do not), and here I find that pricking an *artery* determines an afflux of blood, while similarly injuring a *membrane* produces no derangement of the course of the fluid! And this, although the sensibility of the artery is positively null, in comparison with that enjoyed by the membranes in which it ramifies. If your theory were well founded, the violence of the inflammatory phenomena should be in harmony with the degree of vitality of the tissues. *Experience* shows the precise contrary to be the *truth*. Irritation (to speak your language) is ineffectual in really *irritable* parts, powerful in those deprived of irritability." And *then* he goes on to speak of the "absurdity of such notions."

Now, the explanation of these phenomena, I conceive to be very simple and satisfactory, saying *nothing* of the views of some at the present day, concerning the *extension* of the invisible nervous matter beyond the point of its visible sheath, or other property of reflecting light;* when the artery itself is wounded, the blood flows out and comes in contact with the surrounding parts, and among them this "*irritable membrane*" of Magendie, becoming to them, and it, as *any other foreign body*, and consequently producing, in proportion to the amount of blood extravasated, and the concomitant conditions, more or less *irritation* to these "*really irritable parts*," and this irritation is reflected to the blood-vessels themselves, producing inflammation in the *usual* way. And when the wound extends *only* to the membrane, there is of course only a momentary *prick* with nothing to *keep up* the irritation, and of course *no* inflam-

* See Appendix—Note A.

mation follows, for the irritation must be continued a *certain* length of time to produce such a result.

Of course as to the movement of the globules towards the opening in the vessel, *at first*, they move along with the fluid, the same as they would towards an opening in any other tube or vessel in which they might be confined. It may be urged as against my reasoning that inflammation takes place in opposite states of the nervous system.

Let us examine this point.

A man in a state of health may have some power in a grip of the hand; also a drowning man when almost asphyxiated may have a powerful grip. Hunter says (work on Blood, Inflammation, etc., p. 270), "When there is a strong susceptibility for any one disease in which weakness might also become a predisposing cause, I can believe that in such cases *weakness*, especially if suddenly brought on, may become an *immediate* cause of disease." . . . .

"Weakness produces a consciousness of its own want of powers or incapacity, which produces increased action that even proceeds the length of unnatural actions called nervous." Yet it is an established fact, that if the nervous system is and has long been preternaturally weakened, the inflammatory condition *does not* so readily take place. In such persons wounds will not heal so readily from a want of *power* to take on the adhesive inflammation.

But to the second, or *formative* stage, in which the vessels having opened, are filled with blood, oxygen, etc. I think, when the vessels enlarge they become filled with oxygen, or rather gases, the same as the spongy or black platinum does, viz. by the power of *condensing*, or absorbing *gases*, together with the quality of *diffusibility* of the *latter*.

Probably the gases from the surrounding air get into the vessels, both through the lungs and *directly* through the tissues —most likely in the latter way in *local inflammation*. This gas (which in inflammation is undoubtedly mostly oxygen) *acts* upon a portion of the albumen or albuminose in such a way as to convert it into *fibrin*, very much increasing that constituent, and thereby tending to increase the amount of "coagulable

lymph," as well as to separate it from the other constituents of the blood; and as the vessels *fill up*, an effusion takes place, giving rise to the various phenomena of the resulting stage, such as the formation of false membrane, etc.

Now, that the capillaries *do* become enlarged, there is not a reasonable doubt. All authorities, I believe, agree that in some way the capillaries after a time become "dilated," or "distended," or *enlarged*. (This is the point at which inflammation is generally considered as beginning.) One considers it a result of an injury to the vessels; another, a peculiar state of the blood; a third, a peculiar disposition or action of the corpuscles, as going sideways, or in the wrong place, or without a proper force, or something or another which will produce a *stasis*—as that with many is the all-important condition which acts as the immediate cause of the phenomena of inflammation. Now, the stasis, when formed, undoubtedly acts deleteriously, by preventing the passage of the blood through the vessels, but *it* is *very* likely the result of the *action* taking place in the part irritated. Prof. A. Clark, of the College of Physicians and Surgeons, says: "In health the corpuscles pass through the vessels obliquely, the long diameter being nearly with the long diameter of the vessels. In inflammation the corpuscle advances with the long diameter transversely to that of the vessel. Also, in health the red corpuscles do not touch the walls of the vessel; in inflammation they do, and adhere as also to each other." Prof. Parker, and others say, also, that the corpuscles move faster at a little distance from the point of *stasis*, and that they gradually go slower and slower till they stop. How these phenomena take place, or by what cause they act, of course I cannot tell; but I deem them not the *cause* of the inflammation, but the result of the previous conditions, yet they are undoubtedly means in the production of the *stasis* or clog to the circulation. If I were to hazard an opinion, it would be, that the force of the attraction between the corpuscles (they being the receivers and carriers of oxygen) and the point irritated, and, perhaps, somewhat between each other and the walls of the vessels, hurries them onward, causing confusion, a precipitation from the proper position, and,

may be, causing also through the fulness of the vessels and hurried rush of the blood from the surrounding parts, a carrying along, and, consequently, greater collection of the more tardy white corpuscles of blood which are said to be increased in quantity and collected about an inflammatory part.*

But I suppose the most objectionable portion of this part of my subject, and that which looks the most *theoretic* and insupportable, and even ridiculous to some, is the capillaries becoming similar in condition to spongy platinum, and absorbing or receiving a quantity of oxygen or other gases. But why should it appear ridiculous, inasmuch as the vessels *are* enlarged, and inasmuch as they *do* form, so to speak, a spongy mass of the tissues of which they ramify? Why, I say, is it not reasonable to suppose that these gases will collect therein the same as in the platinum? Suppose the vessels are partially filled with blood before the entrance of the gas, this may not be a hindrance any more than the air in the pores of the platinum is a hindrance to the entrance of oxygen or hydrogen; the blood may even attract the oxygen as it does in the lungs.

I suspect it will not at present be denied that the capillary vessels *do* become enlarged; and I have Prof. Parker's authority that they are not dilated with a pressure of blood or the like of that, but that they open themselves as directly, I believe, by nervous influence as that influence causes muscles in any other part of the body to act.

Professor Parker says: "*in inflammation* the capillary vessels are *changed;* first, they diminish *in calibre*, and then they increase in calibre. They *increase themselves* (not passively), *the vessel has an inherent power* which increases it." Again, emphatically, after referring to the fact that miasmata and other influences affecting the blood, might produce their disturbance upon the nerves, and through them affect the substance of the vessels, he says: "I repeat, the first change that takes place in the capillaries in disease, is contraction; wait a little time, and

* I should have mentioned that the increase of the white corpuscles may also be owing to their *direct formation* in the part by a union of *oxygen* with *albumen*, analogous to the manner in which they are supposed, by Prof. Clark and Dr. Hughes Bennet, to be formed in the lacteals and sympathetic system. See Appendix—Note A.

the next change takes place, and there is increase of these vessels, *increase in calibre, and not because they are compelled to do so by congestion, but because God gave them power; I do not say dilatation.*" (*Prof. Willard Parker, M.D.*)

"The very first act of the vessels, when the stimulus which excites inflammation is applied, is simply an increase or distension beyond their natural size." (*Hunter on Blood, Inflammation*, etc., p. 308.)

Also, Mr. Hunter's experiments upon the rabbit's ear, etc., are valuable demonstrations of this fact.

Even M. Magendie, who opposes everything pertaining to the idea of *Ubi irritatio Ibi fluxus*, after speaking of the stasis (which he makes the cause of inflammation instead of a condition), says, "and around this the capillary vessels are swollen." (*Magendie, On Blood*, etc., p. 261.)

I. F. Palmer (in a note to his edition of Hunter on the Blood, etc., p. 312), says, speaking of microscopic views, etc.: "In all cases where inflammation is well established, the vessels are observed to be increased in number as well as size. . . . . The evidence upon this point is so *universal*, *precise*, and satisfactory, as to render any detail upon the subject quite unnecessary, and any doubt upon the question a mere *excess* of scepticism."

Mr. Paget (*Lectures on Surgical Pathology*, p. 183) says: "The *enlargement* of the blood-vessels is, I suppose, a *constant* event in the inflammation of a part."

We now come again to the *chemical* part of the doctrine. The vessels being opened, and the soft solids of the part in a condition of *porosity*, there is an absorption or condensation into those vessels or pores, of gaseous substances, upon the principle of diffusibility of gases; and these substances *act* upon the *blood*, producing the well known changes in that material—producing or increasing the *defects of nutrition*, which Mr. Paget considers the causes of inflammation, but which seem to me to be *effects* generally. Yet, I think they may be *indirect* or *predisposing;* but *not proximate* causes.

The *diffusibility of gases* is a subject which, as yet, has been but imperfectly studied.

Professor Torrey (of College Physicians and Surgeons) says: "This principle of diffusibility of gases (having referred to condensation of oxygen in platinum), is supposed to be quite universal." He referred also to infiltration of bodies with air; also to the condensation of air upon the surface of bodies; in the pores of water, etc., etc. And said also, "Very likely, the earth being a porous substance, conduces, by its power of condensation of gases, to produce acids and other combinations within it;" also, "charcoal produces its antiseptic properties through its porosity, *absorbing* the noxious vapors in its vicinity."

Professor Graham's investigations upon this subject may also be found interesting and instructive.

So it would seem, from what we can learn, that it would not be at all impossible, but, on the other hand, quite probable that the gases, and especially oxygen, will thus enter the capillaries in the condition in which we have found them. But, perhaps, the objection will be raised here that those metals or other substances, which have the power of condensing gases, are required to be *dry* in order to produce this effect. This, although stated as such, cannot, I think, be proved, as a general law.

There is what is called by Fownes (*Elementary Chemistry*, page 110), a "spurious diffusion" taking place in the lungs, during respiration, through *moistened* tubes. And it would seem to me that the "pores in the earth," which Prof. Torrey speaks of as *condensing gases*, are also in a *moistened* condition; and certainly the "*pores* in *water*," which he also speaks of as condensing gases, and which have long been known to condense, or absorb, oxygen, by which the blood of the marine animals is purified, are *moist* at least, if not *wet*. Besides, the *contraction* of the capillary vessels previous to their opening would tend to expel the blood and produce a somewhat *dry* state of these tubes. Perhaps, also, the following quotations have some bearing upon this point:

"It (sulphuret of platinum) absorbs oxygen from the air while in a moist state, giving rise to sulphuric acid." (*Beck's Chemistry*, page 381.)

"It (sulphuret of platinum) is a brown powder which absorbs

oxygen rapidly, even in drying, and becomes acid." (*Kane's Elements of Chemistry*, page 409.)

It may be said that this is not a parallel case—that the sulphur absorbs the oxygen through its chemical affinity—yet it is evident that, were it not for the condensing power of the powdered metal, these substances would not be brought in close enough contact for the operation of chemical affinity, for sulphur, alone, does not usually "absorb oxygen rapidly."

Let us consider, then, what would be the most natural result of such infiltration of the capillaries with oxygen. And first, the blood of the part would become highly oxygenized, and, to say the least, it is *highly probable* that the degenerated tissues contained in the blood would be almost immediately oxygenized, giving rise to some heat. Mr. Paget (*Surg. Path.*, page 279) says: "Some of it (the heat) is probably due to the oxygenation of the degenerating tissues, a process which we might safely assume to be rapidly going on in the most destructive inflammations, and which is indeed nearly proved by some of the evidences of increased excretion of oxydized substances in inflammations, especially by the increase of phosphates in the urine during inflammation of the brain."

Again. It is not improbable to me, that more oxygen is immediately taken up in such a part than is common in what is called oxygenation or purification of the blood. The red corpuscles are supposed to be the carriers of the oxygen; if so, would there not be an attraction between them and the oxygen, causing them to hurry on to the point irritated and oxygenated, and, being thus overloaded with duty, do their work, and break down in the liquor sanguinis prematurely, and thus allow the escape of their coloring principle and become in a short time somewhat less in number? And, if so, would not this give rise to the phenomena which Prof. Clark, Mr. Paget, and others speak of, viz. "A diffusion of the coloring matter so that the outlines of the individual blood cells cannot be seen," and a diminution in the quantity of the red corpuscles?

Again: The protein compounds are capable, say the physiologists, of being converted from one to another.

"The protein compounds may be changed from one to an-

other, *especially albumen may be changed to fibrin.*" (Prof. Clark.)

Now, then, may not and does not this oxygen, of which I have spoken, *change* a portion of *albumen* to fibrin? I know of no reason why it may not. In no chemical analysis, I believe, of albumen and fibrin is there anything to contradict this. In some of the analyses, carbon and some of the analogous elements are greater in the *albumen*, while the oxygen is less in the *fibrin*—the oxygen, of course, might neutralize the first of these and increase the latter, so as to form fibrin from albumen. But the most approved analysis of these two substances (says Dr. J. C. Dalton),* and also of casein, is to consider them different combinations of sulphur and phosphorus with protein, as indicated by the following formulæ:

Protein, $C.^{400}$ $H.^{310}$ $O.^{120}$ $N.^{80}$
Fibrin, $C.^{400}$ $H.^{310}$ $O.^{120}$ $N.^{80}$ S.P.
Albumen, $C.^{400}$ $H.^{310}$ $O.^{120}$ $N.^{80}$ $S.^{2}$ P.

Now it is very natural to suppose that this extra equivalent of sulphur in the albumen might be taken up by the oxygen (similar to the manner in which it is taken up in *sulphuret* of *platinum*, before referred to), and form an acid, and subsequently a sulphate, or perhaps acidulate and partially change the nature of the blood, preventing it from duly supplying the usual secretions and at once affecting nutrition.† This, with what has been noticed previously and what will be hereafter the overloading the corpuscles with oxygen and the decrease of albumen in the blood, would to a greater degree favor the breaking up of the red corpuscles of the blood of the part, for, says Fownes (Elementary Chemistry, page 471), "it appears singular that the red corpuscles, which are so easily dissolved by water, should remain uninjured in the fluid portion of the blood. This seems partly due to the presence of saline matter and partly to that of *albumen*, the corpuscles being alike insoluble in a strong solution of salt, *and in a highly albuminous liquid.*"

This, too, would account for "*the increase of fibrin*" in the

* Now Professor of Physiology in the College of Physicians and Surgeons.

† See Appendix—Note B.

part and in the blood generally, and the greater the number of inflammatory points, as in inflammatory rheumatism, the greater would be the aggregate amount of fibrin in the blood.

But the *decrease of albumen* is not often noticed, for the reason, perhaps, that it is thought of little moment, and also that the diminution which would take place, as, for instance, say three parts in a thousand, would be hardly noticeable, while the same quantity of *increase of fibrin*, three parts in a thousand, would be quite conspicuous. Prof. Clark, however, says something as follows: "In inflammation the fibrin is increased, and especially in inflammatory rheumatism. It is even perceptibly greater during the exacerbations of this disease, and less in the remissions, *while the albumen, on the contrary, is greater during the remissions and less during exacerbations.*"

It is not at all improbable that the albumen is in greater quantity in the blood previous to the inflammation, acting somewhat as a predisposing cause. It is well known that "high livers" are exceedingly obnoxious to attacks of inflammation.

Prof. Clark says, he thinks albuminuria is a frequent cause of arachnitis and other inflammations of or about the brain. (As to the irritation produced by the urea, which is the probable cause, I shall speak hereafter.) If these inflammations take place in the earlier stages of the albuminuria, it is a case in point, for says Watson (Practice of Medicine), "In the early part of this disease the albumen is abundant in the *blood.*" But be this as it may, there are many circumstances which go to prove that when the system is overloaded with oxygen, in whatever manner it receive the same, the *fibrin of the blood is increased in connection with inflammatory symptoms.* Prof. Torrey (in his lectures) says: "If pure oxygen be breathed any great length of time it causes a general inflammatory action in the system, producing death." Mr. Turner says (Chemistry, page 153): "When an animal breathes pure oxygen gas, no inconvenience is at first perceived, but after the interval of an hour or more the circulation and respiration become very rapid, and the system in general is highly excited, symptoms of debility subsequently ensue, followed by insensibility, and death occurs in six, ten, or twelve hours. On examination after death the

blood is found highly florid, and the heart acts strongly even after the breathing has ceased."

B. W. Richardson, Esq., in a paper on the fibrinous constituent of the blood in relation to disease (reported in Braithwaite's Retrospect, part 27th), states: "There can now be no doubt that the presence of oxygen in a certain proportion in the body, and the presence of a moderate degree of temperature, are both necessary to secure the due formation of fibrin;" he says also that "Dr. Gardiner had shown that if an animal were made to breathe pure oxygen for a little time the fibrin of the blood was increased in amount," and also that he, Richardson, had carried Dr. Gardiner's experiment further, and had found that if an animal were made to breathe, for a great length of time, an atmosphere containing an excess of oxygen, it sank and died at last, its heart loaded almost to bursting with fibrinous concretions." M. Magendie's experiments upon the blood with gases, etc. (Lectures on Blood, etc., page 211), show that they exert much influence upon that fluid.

Of the Third, or *resulting* stage of inflammation, it was not my intention to enter much into detail; and had it been, and had I the knowledge requisite, the length which my paper has already assumed would have caused me to desist. (For I hoped to have my thesis read and *thought* to consult brevity as an attraction for it.)

Still, I must barely notice some of the more prominent points in this division of the subject, and afterwards "*speculate*" as to the cause of the so-called different varieties and conditions of inflammation, and also of certain diseases which *approximate* or *assume* the inflammatory movement, and advert to the treatment, and the action of certain remedies.

First of effusions: These, we are told, are of *three* general varieties, as: serum, coagulable lymph, and blood. True serum is not often seen, and when it is, it is said to be in "low degrees of inflammation" (Paget, Surg. Path., page 213), and is probably more the result of passive congestion, forcing out by pressure the serum of the blood, than of true inflammation. Yet what is considered *serum*, commonly, is the primary effusion of active inflammation, and contains in *solution* a greater

or less quantity of *fibrin*, and is probably produced by chemical action as before spoken of. (In speaking of *chemical action* here or elsewhere, as taking place in the living system, I would of course be understood that it is to an eminent degree controlled by *vital* action.)* As the morbid action further increases, the conditions of greater determination of blood to the part, *stasis*, etc., ensue. At the same time a greater amount of *fibrin* is produced and dissolved in the serum, which through pressure, etc., is caused to exude, and we have then the effusion of "coagulable lymph."

Yet the effusion is governed, somewhat, by the part involved, depending no doubt upon the amount of innervation, vascularity, etc., as well as on the previous condition of the blood.

"As to the effusions of blood," says Mr. Paget (ib., page 215), "I believe they imply no more than *accidents* of the disease." They are probably produced by great pressure, and perhaps aided in some cases by some degeneration of the tissues of the vessels.

As to the disposition of these *exudations*, a few words: What is called serous effusion is, as a general rule, sooner or later absorbed; while the disposition of the "coagulable lymph," it seems to me, depends upon the powers of the system, or of the part affected. When the general system is sthenic in character, a common or moderately active degree of inflammation will produce an effusion of "coagulable lymph," and that will take on a species of *organization*, and "false membrane" will be formed.

If the system is somewhat *asthenic* at the first, with an albuminous diathesis, the remaining activity of the system will be so overcome as to allow the "coagulable lymph" partially organized to degenerate into *pus*.

And when again the system is *sthenic* in character, and the inflammation is *extremely violent*, or when it attacks a vital organ, the strength of the system even then succumbs to such an extent that the "coagulable lymph" *degenerates to pus*, accounting for the fact that in some instances, and in some parts

* See Appendix—Note C.

of the body, we have adhesive inflammation, while in other instances and parts, there is the suppurative variety. Also, as stated by Mr. Paget, the condition of the blood at the time of the commencement of the disease would have some influence upon the kind of effusion, and of course upon the product of such effusion.

Mr. Paget (Surg. Path., page 230, *et seq.*) speaks of *development* in regard to organization of false *membrane*, etc.; also (ib., page 247) of the "*degeneration* of inflammatory lymph into *pus*."

Those diseases which approximate to a certain degree the inflammatory form are principally, *nervous*, *febrile*, *and blood diseases*. In fact, nearly or quite all diseases seem to me to have in some one or another particular, more or less similarity to some of the conditions or forms of inflammation.* Mr. Travers has said, "that a knowledge of the phenomena of inflammation, the laws by which it is governed in its course, and the relations which its several processes bear to each other, is the keystone to medical and surgical science."

The nervous diseases are similar to inflammations, in that they produce, or are accompanied by, or are, irritations. As irritation is also the first act in inflammation, it will be interesting to know why such irritations do not produce inflammations. I think they always do *tend* in that direction, but the condition of the system, the quantity and quality of the irritation, greatly modify its results. If the system is in a healthy condition, blood in a normal state, or with an albuminous diathesis, an exposure to cold or other vicissitudes, sufficiently powerful, will commonly produce an irritation of the system which will go on to the formative stage of inflammation. If in such a condition of the system, a person meets with a sudden injury which greatly shocks the nervous system and the powers of life in general, there will be a "constitutional irritation" following, which will be like a feeble, fluttering, irregular, often-repeated and unsuccessful attempt at reaction, which may fail altogether

* A *deranged nutrition* would seem to me to be a good general definition of *disease*, and true inflammation I deem a typical form of this derangement.

and end in *death;* and really criminal would be the man who would treat such a case as he would developed inflammation. Instead of being depletory, the treatment should be eminently sustaining, as also to a greater or less extent should be the plan in all forms of irritation where the condition of the nerves or state of the blood will not allow them to pass on to the formative stage of inflammation.

Again, irritation will take place when from any cause the blood is very poor in quality, or *much* diminished in quantity, for the reason that the nerves being but partially supplied with the materials which enough good blood would furnish, a kind of reflex, or, I had almost said, instinctive action is set up upon every slight exposure.

This action, though it will in time wear out the system and the patient, is, nevertheless, as I believe, Nature's attempt to restore. The irritation acts like the irritation of inflammation, and had the blood the qualities to be chemically acted upon by external influences it would, as it appears to me, pass on nearer to a state of health, or whip on around to inflammation. In this form of irritation it is plain that the treatment should be soothing and sustaining—the blood *must* be enriched. Such a state of things should, if possible, be diagnosticated; to deplete here, however much the symptoms may at times assimilate true inflammation, would be removing the last chance.

There is another peculiar form of constitutional irritation—Tetanus—it may be idiopathic or traumatic, is most commonly the latter, which is caused by "wounds involving the fibrous structure of the contused or lacerated kinds." (*Prof. Parker.*)

The injury evidently affects the nerve of the part, either through a peculiar disease of the nervous matter, or by calling into action its excitability, so as to extend the influence to the entire spinal marrow, so that powerful excitability is caused throughout the whole spinal nervous system; and, instead of causing action only among the minute nerves going to the capillaries, or of the sympathetic system as in the irritation of inflammation; slight irritation, or scarcely none at all, even, will produce forcible, distressing, and prolonged contractions

throughout a part or the whole of the voluntary muscular system.

THE IRRITATION OF BLOOD DISEASES.

The material said to poison the blood, besides directly affecting the nerves, very likely impoverishes the blood in such a manner that it does not afford the proper amount of *nutrition;* the nerves suffering in common with the rest of the system, as before spoken of, become irritable. But the impoverished state of the blood will not allow the vito-chemical* changes necessary to the formation of the second stage of inflammation, except in such diseases as albuminuria, and a few others where the poison seems to affect the nerves previously to the impoverishing the blood to such an extent as to prevent the procedure of inflammation.

In venomous poisons the nerves are evidently affected at once—overpowering them—indicating *stimulus.*

Fevers approximate inflammations, in that they are attended with a modified form of the *first* stage, and an attempt at the second; and they assume the inflammatory condition as complications, when by any means the blood becomes of a nature to be acted upon. The cold stage is a protracted contraction of the capillaries preventing much circulation therein, and consequently producing internal and venous congestion. This stage of the fever is followed by reaction, an opening of the capillaries to a certain extent, analogous to inflammation; but the cause which has acted upon the nervous system through the blood, and with the exposure has produced this state of things, has also in many cases so changed or impoverished the *blood* itself, as to prevent the vito-chemical action,* and consequently no true inflammation ensues, generally.

Some forms of fever, however, in some climates run so near the inflammatory condition as to indicate depletion, and sedatives are very common to prevent it "running high."

In low forms of fever, as typhoid and typhus, depletions and sedatives are rarely resorted to; but *stimulants* and non-

* See Appendix—Note C.

rishment are given as freely as the patient's stomach will bear. Here we have, *with* an overpowered nervous system, a decidedly innutritious and "defibrinized" state of the blood, and imitating nature, we endeavor to get up an *action* in the system; we do not want inflammation, yet the action producing it is nearest like the healthy action of any that can be aroused; so we give the remedies which, in inflammation, would increase it. Finding our patient getting better and better, that the action we have aroused is raising him higher and higher, and that his blood is increasing in quantity and becoming better in quality, we continue the remedies; and continue till perhaps we continue a little too long and too strong; passing the happy medium, when our patient has *inflammation* "complicating his *fever*," or without apparently carrying the remedy too far, the system being aroused, passes on with a pathological force to inflammation, if not carefully watched and checked.

If this is correct reasoning, large doses of sulph. quinine at the proper time, and within proper limits, would be highly useful in typhous conditions. It has been given, too, with apparent good effects. (See report of *Dr. W. Barclay*, in *Braithwaite's Retrospect*, part 27.)

HOW DO REMEDIES ACT IN INFLAMMATION?

When a common "cold" is arrested in the first stage—said to be prevented—it is accomplished by allaying nervous irritation, etc. A full dose of opium and a warm bed, or warm fire, will do it, directly allaying the irritation, relaxing the fibres and preventing or arresting the contraction of the capillaries, and sometimes quelling the reaction if it has taken place, especially if astringents* are added to contract the open capillaries, if this can be done previously to the chemical actions of the second stage, the stasis, etc.; after which, such things might not only be of no use, but be even harmful.

After inflammation has existed for some time and the action becomes somewhat quieted and the stasis is cleared away; or,

* Or, perhaps more properly, remedies which act upon the vaso-motor nerves of Brown-Séquard.

in the *chronic* form of the disease, then astringents and stimulants are used—said to "create a new action;" they probably produce a contraction of the vessels with this new action, which if carried too far would produce the reaction, and the results, as it invariably increases the trouble during high activity of acute inflammation. The warm bed, or warm room, probably aids, by helping to relax the fibres and allow the opening of the perspiratory tubes.

Warm drinks and a warm bed will check or prevent a cold by preventing the contraction of the capillaries, opening the pores, etc.

Also a large draught of cold water will do the same by its *sedative* effect, and by checking internal congestion, throwing the action to the surface—the external warmth aiding and opening the pores as before, and altogether preventing the contraction of the capillaries, etc.

Calomel, as an antiphlogistic, in connexion with its debilitating action upon the nervous system, acts directly upon the blood—impoverishing it—producing in it some *change*, perhaps through chemical action, preventing further production of fibrin, and of course checking further effusion and depositions of the same.

Antimony is a powerful sedative, and to this probably it owes its principal force as an antiphlogistic, quieting the nervous and vascular action. It also acts upon the blood to a greater or less extent.*

The principal antiphlogistic action of catharties, aside from the irritating substances they may remove, is probably *sedative*.

Blood-letting is the most powerful sedative, and hence its power to quell the action of inflammation, though its effect of itself is not lasting; as it only removes a portion of the blood, and does not *change* it so as to prevent further diseased action, as the production of effusion, deposition of fibrin, etc., if the nervous system arouse so as to carry on such action. By repetition, repeated *shocks* are given to the nervous and vascular systems, till finally the *powers of nature give up* either partially or entirely; and if after such repeated shocks and starvation,

* See Appendix—Note D.

you can partially arouse them again by careful watching, and keeping up with stimulus till the system can add more blood to the little that is remaining, the process will be apt to be so *slow* that the system will stand a chance to move *surely* on to a state of health.

Why cannot something be given to quiet the irritated nervous system, and at the same time relax the opening muscular action of and *astringe* the capillaries, and in that way prevent the further progression of the infiltration and chemical action of the *formative stage* without so impoverishing or abstracting the blood?

Does not opium act somewhat in this way, as an antiphlogistic? And might it not be made to act *more* so by the addition of a more powerful sedative, and something *known* to act directly astringent or contracting to the capillaries?*

Thus far I have said nothing about the heart, as its actions are well known. If the capillaries are active the heart is active, and sedatives, etc., of course, act upon *it*, helping to quell further trouble.

Once more: How does quinine act in intermittent fevers?†

Is it not by a peculiar influence upon the nervous system, and by giving tone and strength to the capillaries? giving them power to continue their *action* through the cold or congestive stage, and thus preventing reaction!

Does it not act here as a tonic as well as in other cases in which it is given?

Is not its "peculiar antiperiodic" action eminently tonic? giving tone to the *general* capillary system? while, what are *commonly* considered tonics, produce nearly or quite the same state of things *merely* upon the capillaries of the digestive organs?

Why not give *sulph. quiniæ* in combination with *opium*, in *Asiatic cholera*, especially in the first part of the disease, with a view to keep up the nervous power and *capillary circulation*, and thus *prevent* the collapse?†

After what I have said, it will be proper to allude to the

* See Appendix—Note D. † See Appendix—Note E.

production of animal heat, and to its increase during the inflammatory movement.

I believe it is a settled opinion of physiologists of the present day, that the *heat* of animals is produced by the chemical union of oxygen with the worn-out tissues of the body, and with the hydrogen and carbon taken in with the food.

Now, I conceive this process, especially the union with the worn-out tissues, to be always proceeding more rapidly during an inflammatory movement in a part, than when the same part is acting physiologically, and hence I am of the opinion (contrary to authority), *that heat* is *always* increased in a part, during the second or formative stage of inflammation; and that the quantity of apparent heat depends upon the *formation* and *situation* of a part, and on the condition of concomitant organs, or their functions. Prof. Clark, who is of the opinion that the increase of heat is not a necessary condition of inflammation, that when it does exist, *it is not generated* in the part, but "brought by the blood" through the active circulation—says, speaking of animal heat: "We are prevented being overheated partly by the contact of cool air, and a conveyance of the heat away from the body by a frequent change of air, and also by direct radiation, and by *evaporation* of the *perspiration*." He also said on another occasion, "*The veins have a greater capacity for heat than the arteries* (that is, they will hold more without showing it)."

Now, it is admitted to be a *fact* that *external* inflammations *are* always accompanied by *increase* of *temperature*, and the *free* heat in such will be found, I think, to be in proportion to the activity of the inflammation, and the amount of *fever* accompanying it. The *fever*, by checking the function of the *perspiratory* apparatus, prevents the procedure of evaporation, and thereby closes the principal outlet or safety-valve of the system, and prevents the escape of the heat produced. Hence the great heat of inflammatory fevers.

As to increase of temperature of the internal organs, it is hardly to be supposed that so much heat is produced in them during inflammation; yet quite a considerable amount may be produced and become, as it were, *latent*, from being surrounded

with good conductors of heat; and especially on account of their intimate connection with *veins*, and a circulation in them of a large quantity of *venous* blood, which, Prof. Clark says, has so much greater capacity for heat than arterial blood.

Through absorption, conduction, and I might say convection, too, we find that these organs might be relieved of the *heat* generated during inflammation, without the same being apparent. If this were true, we should expect the general temperature of the body to be increased; and Prof. Clark says that such *is* the *fact*. He attributes it, however, to the *stoppage* of *the secretions*, and not at all to the generation of heat in the inflamed part."

He says: "The heat never exceeds the maximum or standard temperature of the body;" and also that we have no reason to believe the "normal function to be going on more rapidly, and consequently *none* for believing that more heat is generated in an inflamed part."

It would seem to me, considering the intimate connection of all parts of the body by the blood-vessels, etc., that one part could not be much heated without the excess of caloric being conducted to, or throughout the body in general. And the blood being the principal medium of conduction, wherever there is the greatest amount of the blood circulating in a given length of time, *there* would be the maximum of heat, as at the centre of circulation. The dog and analogous animals cool the blood of their systems through the mouth, and yet the mouth does not become the coldest part of their bodies.

In regard to the "increased natural action" of a part, Mr. Paget says (*Surgical Path.*, p. 278 *et seq.*): "But the proper heat of inflammation (I mean that which is measurable by the thermometer), cannot, I think, be wholly thus explained" (by determination of blood). "Some of it is probably due to the *oxidation of the degenerating tissues*."

And then speaking of the probability of the oxygenation of the wasted tissues, etc., he goes on to say, "If it be so, the increased heat *will give no ground for regarding the inflammatory process as the result of a greater exercise of the formative force* than is employed in ordinary nutrition; *none* for

speaking of it as *increased* nutrition, or *increased* action; rather, this sign may be added to the evidences that the inflammatory process presents, of diminished formative force, and of premature, *rapid degeneration* in the affected part."

As to "passive congestion" * which I have mentioned heretofore, I need only say that I believe it takes place in a condition of the vessels *opposite* their inflammatory condition.

It usually takes place in the veins, and is very likely a dilatation of the same, and filling up with blood through the action of a "force behind."

When it does take place in the arteries or capillaries, it is, I think, in a low condition of the system, and a relaxed state of the vessels—a *want* of proper action and nervous force.

The larger vessels of the body, especially the veins, are proved to take on passive congestion, as they have normally but little action, and have no direct active function to perform.

Professor Smith (of the Coll. Phys. and Surg.) says: "The large blood-vessels are only reservoirs and roads for the receiving and transportation of the blood."

"The *functions* being performed in the capillaries, both the physiological and pathological."

* See Appendix—Note E.

APPENDIX.

THE following *notes*, although referred to as being appropriate to be read in the connection from which the references are made, will be found, I think, more intelligible and be better understood if read after an entire perusal of the original thesis.

They are intended more as supplementary than otherwise, and as a reminder to the reader of the bent of the medical mind during the past few years, showing a tendency to look *more* to the *nerves* as a cause, or at least to the *disturbance* of the nerves as a *cause* of disease, as well as a decided tendency to treat the results of these disturbances upon well known *chemical* principles; thus, as it appears to me, indirectly proving the chemical ideas of the foregoing pages.

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39 Bedford Av., Brooklyn, N. Y.,
March 27, 1867.

NOTE A.

I do not suppose, of course, that in this crude theory of my boyhood I have hit upon a complete delineation of the process of inflammation which may, in detail, be demonstrated as *positive fact;* and yet *I do* believe that the process of *nutrition* is a *chemical* process, regulated and controlled by the *vital power* through the medium of the *nerves* acting upon the capillary blood-vessels; and that *inflammation* is *one* form of derangement of this nutrition; and I think the progress of medical science, the development of new physiological and pathological truths, and particularly the changes in the opinions and practices of many of the representa-

tive men of the medical profession during the past twelve to fifteen years, tend to a positive demonstration of the truth of these opinions.

While I admit the difficulty of proving that the capillary blood-vessels *positively open* of themselves, from the supposed lack of the peculiar kind of muscle for such action, and the supposed impossibility that such muscle could have any point of attachment from which to act, yet I can conceive that such a condition might take place through some reflex action, perhaps, or as a kind of rebound after sudden contraction, such contraction throwing the blood out of the vessel, and the rebound or return of the vessel to even its previous size, producing a condition of partial emptiness of the capillaries, and thus a state of porosity of the part. I had hoped before the publication of this paper to have completed some investigations looking towards the proof of the extension of the muscular and nerve fibre to the minutest capillaries, or at least the extension of an inherent power of contraction and dilatation of these capillaries through nerves or a nervous influence, reaching beyond the point which has as yet been demonstrated, and perhaps beyond the point which *can* be demonstrated with the present power of the microscope; * but as these investigations are, as yet, incomplete and unsatisfactory, I withhold them, hoping at no distant day to complete and publish them in connection with a paper on the subject of *Nutrition*. As coming nearest to the views long held by me, I take great pleasure in recording here some of the opinions as expressed in numerous published lectures, and as partially reiterated in the late lectures before the N. Y. Academy of Medicine, of that eminently progressive man of the age, Dr. C. E. Brown-Séquard. I quote first from Braithwaite's Retrospect for 1861, part 42, page 29. When speaking of reflex paraplegia, etc., he says: "As it is now well established that blood-vessels contract with energy, and sometimes even are seized with a real and prolonged spasm, whether by a direct influence of their motor nerves, or through an excitation, which, from some centripetal or excito-motor nerve, has been reflected upon them by the cerebro-spinal axis, *there is no need of showing here that blood-vessels are just like muscles of animal life*

* Dr. A. Clark, Professor College of Physicians and Surgeons, says the larger capillary vessels of the brain are found to be surrounded by the involuntary muscular fibre, and also longitudinally with a layer of fibrous tissue, and that both tissues disappear in the very minute vessels.

as regards their relations with the nervous system." I quote next from the New York publication of the *London Lancet*, for April, 1866, page 217 :

" One of the most important of the recent advances in physiology and pathology consists in the demonstration that the nervous conductors of the various kinds of sensitive impressions and of the reflex phenomena, and also for the transmission of nervous force to muscles, blood-vessels, etc., are absolutely distinct one from the other as regards their functions. Leaving aside the nerve-fibres of the brain, some of which have functions altogether different from those of other parts of the nervous system, I have ascertained that, besides the four distinct kinds of nerve-fibres of the higher senses, there are at least eleven distinct kinds of nerve-fibres in the spinal cord, and in the cranial and other nerves. The following table shows what are the distinct functions of these eleven kinds of nerve-fibres. They are—

1st. Conductors of impressions of touch.
2d. " " tickling.
3d. " " pain.
4th. " " temperature.
5th. " " contraction (muscular sense).
6th. Incito-motor conductors.
7th. Incito-nutritive and secretory conductors.
8th. Voluntary motor conductors.
9th. Involuntary motor conductors.
10th. Vaso-motor conductors.
11th. Nutritive and secretory conductors.

" I hardly need to say that the number of distinct nerve-fibres is probably much greater than is shown by this table ; but the demonstration of the distinction of other kinds of nerve-fibres (such as those serving to sensations of hunger, thirst, pressure, or to voluptuous sensations, etc.), is not yet sufficient.

" Almost all the symptoms of functional (and I might say, also, of organic) nervous affections, take place through one or other of three modes of alteration of the properties and functions of the fifteen kinds of conductors above named. Those three modes consist in: 1st, a diminution or loss of power ; 2d, an increase of power ; 3d, a morbid state producing a great variety of phenomena. In the nine kinds of conductors serving for the transmission of

sensitive impressions, the first of these three modes of alteration constitutes *anæsthesia*, the second *hyperæsthesia*, and the third is the cause of *morbid sensations* (including the so-called *referred sensations*).

"I will not enter into details here about the kinds of nerve-fibres which I call incito-motor, incito-nutritive, or secretory, or about those which I simply name nutritive or secretory; but as it would be impossible to understand the future lectures of this course without some knowledge of the properties and functions of these nerves, I will give, as briefly as possible, a few notions concerning their physiological and pathological history.

"1st. *Incito-motor nerves.*—These are the well known excito-motor nerves of Marshall Hall. A great many facts prove that they are absolutely distinct from the sensitive nerves. All the reflex movements of the muscles of organic or animal life (including the excretory ducts of glands, the blood-vessels, etc.) originate through an irritation transmitted by these incito-motor nerves.

"2d. *Nutritive and secretory nerves*, and *incito-nutritive and secretory nerves.*—That more appropriate names should be given to these nerves, I will not deny; but so long as their real mode of action remains somewhat doubtful, I think it is better to call them by names which only imply what we positively know of them—i. e. that they are agents of modification of secretion and nutrition. The *secretory and nutritive nerves* are in many respects the antagonists of the *vaso-motor nerves*. While these last nerves, when put in action, produce a contraction of blood-vessels and all the phenomena which I have shown to ensue from that contraction (such as a diminution in the quantity of blood, a diminution of sensibility and other vital properties, and of secretions),* the nutritive and secretory nerves, on the contrary, when put in action, occasion a dilatation of blood-vessels and all the phenomena that ensue from it, as shown by experiments of Czermak and of Cl. Bernard. I proposed long ago (in my lectures at the College of Surgeons in 1858)† an explanation of the action of these nerves, which becomes more and more probable with the frequent discovery of new facts concerning these nerves. The explanation is, that the secretory and nutritive nerve-fibres act upon the tissues so as to increase their

* See Course of Lectures on the Physiology and Pathology of the Central Nervous System, 1860, p. 142.

† See my Course of Lectures, above quoted, p. 149.

chemical interchanges with the blood, and that, in consequence of this increase of chemical interchange, blood is more attracted to the part, and as an effect of this greater afflux of blood, there is a dilatation of blood-vessels. In many of the future lectures I will mention phenomena due to this dilatation of blood-vessels from an irritation of this peculiar kind of nerves. I will only add now to what I have already said on this subject, that it is chiefly by a reflex action that these nerves produce their peculiar effects. The redness, the congestion of parts attacked with neuralgia or of neighboring parts, the secretion of tears when the eye is irritated or the skin of the face pinched, the secretion of mucus from the nose, or from laryngeal, tracheal, or bronchial mucous membranes, or the diarrhœa produced by cold, and an immense number of facts in which there is a congestion or a secretion as a result of an irritation of cutaneous or other nerve-fibres, are all effects of the peculiar influence exerted by secretory and nutritive nerve-fibres on glands and other tissues.

"These nutritive and secretory nerve-fibres are, as I will try to prove in future lectures, the agents of production of inflammation, suppuration, and ulceration, by a reflex action. They are the channels of production of meningitis, encephalitis, or myelitis, when those inflammations are due to cold, to a burn, or to a visceral affection. They also have a great share in the production of many functional nervous affections, and particularly tetanus. Besides, through the agency of these nerves much may be done for the treatment of nervous affections, as I will show hereafter.

"The incito-secretory and nutritive nerve-fibres are the incident or centripetal nerve-fibres which, by a reflex influence, act upon the centrifugal secretory and nutritive nerve-fibres. Their distinct existence is not fully demonstrated, but many facts render it extremely probable.

"The causes of functional nervous affections can be divided into several groups. 1st. An irritation by worms, by teething or decayed teeth, by cold, by a burn, a wound, an inflammation, a neuralgia, etc., of centripetal nerve-fibres (the incito-motor, the incito-nutritive, and some others). 2d. An alteration in the quantity or quality of blood. 3d. Both the two preceding kinds of causes coexisting together, as in cases of typhus fever, of variola, of diphtheria, of uræmia from disease of the kidneys, etc.

"I will not now insist on the mode of action of these causes, as that

will be better done in treating of each nervous affection separately; but there are a few general remarks which will be in their proper place in this introductory lecture. There are two general rules which particularly deserve attention.

"1st. *The same peripheric cause of irritation acting on the same centripetal nerve may produce the greatest variety of effects, including every functional nervous affection or disorder.* This is well illustrated by the effects on the eye of a neuralgia of the infra- or super-orbitalis nerves. There are cases showing: 1st, spasm of the sphincter of the pupil; 2d, mydriasis; 3d, spasm of the orbicularis palpebrae; 4th, paralysis of the orbicularis; 5th, paralysis, or spasm of one or several of the muscles of the ocular globe; 6th, photophobia; 7th, amblyopia, or amaurosis; 8th, congestion, or inflammation of the conjunctiva or of other parts of the eye; 9th, diminution or increase of the secretions of the lachrymal and other glands; 10th, a cataract; 11th, a glaucoma.

"Other instances, though less striking, might be adduced. I will only mention what we know as regards the effects of cold air on persons coming out of a theatre. One may be attacked with a sore throat, a second with ophthalmia, a third with enteritis, a fourth with a nephritis, and many others with any other visceral inflammation; while one may be attacked with a facial paralysis, and others with almost every other partial paralysis, or with chorea, with contracture, with meningitis, or an inflammation of some part of the nervous centres. It is true that here it is not the same part of the skin which is acted upon by the sudden lowering of temperature; in most of such cases, however, it is the front part of the chest and the neck that are subjected to the influence of the cold air.

"It is probable that the great variety of phenomena following an irritation of centripetal nerve-fibres depends on differences of excitability of some parts of the nervous centres in different individuals. I have examined carefully, on a large number of men, the effects of tickling the sole of the foot, and found that these phenomena differed considerably in different individuals. In one, laughter predominated; in another, involuntary screaming, or shedding of tears, or jerks either in the irritated limb or in both lower limbs, or a general trembling, or a spasm of the diaphragm, or an almost tetanic rigidity of the irritated limb. I need not add that in some individuals there was hardly any effect produced when, being prepared for the irritation, they fought against its influence—a fact

which, with many others, shows that by an effort of the will we sometimes can, at least in a certain measure, prevent the production of reflex phenomena.

"I will not say more at present on this subject, leaving for other lectures the demonstration that it is through a real reflex action (i.e. through a mechanism similar to that of reflex movements) that the morbid effects of an irritation of centripetal nerve-fibres take place.

"2d. *The degree of excitability of the different parts of the nervous system may increase or decrease considerably in the same person under the influence of various causes.*—This proposition is of so great an importance in the diagnosis and treatment of nervous affections, that it is only by the light it throws on many otherwise obscure cases that we are enabled to recognise their nature, and to apply the proper treatment. Many parts of the nervous system that are completely, or almost completely inexcitable in a healthy condition, become excitable, and sometimes in a wonderful degree, under the influence of several morbid causes. Amongst these parts, I will point out the gray matter of the spinal cord, and the nerves of the tendons, aponeuroses, dura mater, periosteum, bowels, bladder, kidneys, and some other viscera. Many causes, very different one from the other, may increase the excitability of the various parts of the nervous system. I will mention here only the principal of these causes: 1st. I have found that muscles, nerves, and the spinal cord, become more excitablewhen laid bare, and particularly when the air in contact with them is richer in oxygen than the ordinary atmospheric air. 2d. A congestion or an inflammation will increase the excitability of nervous tissues everywhere, but nowhere so markedly as in the gray matter and some parts of the white columns of the spinal cord, which, in consequence of that increase, will become able to produce referred sensations of pain, of cold or heat, of tickling, etc., and phenomena due to an irritation of motor, vaso-motor, and nutritive nerves. 3d. An afflux of blood, such as occurs merely by gravitation, or after a section or a paralysis of the sympathetic nerve, or a lesion of the spinal cord, the medulla oblongata, or the base of the brain, will also increase the excitability of peripheric nerves in the parts where this afflux takes place. 4th. Certain remedies or poisons (strychnine particularly) will increase the reflex excitability of the spinal cord to a wonderful degree; while others, such as atropine, chloroform, etc., will diminish it considerably. 5th. Certain

diseases, such as tetanus and hydrophobia, will increase extremely the reflex excitability of some parts of the cerebro-spinal axis. 6th. A great loss of blood, anæmia, chlorosis, will also increase the reflex excitability of the nervous centres.

"The increase of reflex excitability in cases of extreme debility, as in old age, or after a loss of blood, or other causes of insufficient nutrition, would be very difficult to understand if we did not know that the reflex excitability of the spinal cord can be increased under the influence of certain substances (strychnine, principally) when no blood at all remains in the blood-vessels of that nervous centre, as proved beyond the possibility of doubt by Messrs. Martin-Magron and Buisson. The excitability of sensitive nerves may also be increased when the quantity of blood is much diminished, as we often observe in fingers that have been exposed to cold air or cold water. It seems, from a review of all the facts I know bearing on this point, that certain substances contained in blood altered in quantity or quality will act on the excitability of nerve-fibres in the nervous centres, or in the nervous trunks and branches, so as either to increase it, as is done by strychnine (on the gray matter) and oxygen (everywhere), or to decrease it, as is done by carbonic acid, atropine, chloroform, etc.

"To conclude what I wish now to say on the excitability of the nerves, I will only mention—1st, that I have ascertained that the excitability of the same nerve varies in different parts of its length, and to such a degree that in some parts the excitability seems nil, or is very slight, while in other parts it is considerable; 2d, that I have shown by positive experiments that the excitability of muscles, of nerves, and of the spinal cord, may be very much increased, while the *force* developed by the action of those parts is very small. For instance, atrophied muscles, unable to contract with half the force shown by healthy muscles, will, however, contract under the influence of an excitation that will produce no effect on healthy muscles.

"I will say only a few more words on the causes of functional nervous affections. The important discussions between Virchow, Spiess, and others, on the share of the nervous system in the causation of the various morbid alterations of tissues and organs, have been very useful in bringing forward many interesting facts; but the exclusiveness of the two opposite schools, at the head of which are the eminent men I have just named, has thrown a great deal of ob-

security on questions which, considered with less partiality, might have been solved easily. It is certainly true, as maintained by Virchow, that nutrition and secretion, normal and abnormal, can be carried on without the intervention of the nervous system; but this does not at all prove that the nervous system cannot interfere for good or for evil, in the nutrition and secretion in the various tissues and organs. For instance, there is no doubt whatever that an inflammation, followed or not by suppuration and ulceration, can take place without any intervention of the nervous system; but as will be proved in one of the ensuing lectures, there is no doubt also that inflammations not only can be, but very frequently are, produced by a nervous agency. Indeed, facts are extremely numerous that establish clearly—1st, that normal nutrition and secretion do not depend essentially on any interference by the nervous system, and that all morbid changes in these fundamental organic functions can take place without any nervous influence; 2d, that the nervous system may, and almost constantly does, influence nutrition and secretion, and that it frequently produces, or helps to produce, a great variety of alterations of these two fundamental functions."

I deem it no proof of the fallacy of my theory of nutrition and inflammation that, as maintained by Virchow, "nutrition and secretion, normal and abnormal, can be carried on without the intervention of the nervous system," as I hold, and have heretofore stated,* that in the process of nutrition the capillary blood-vessels are used as the retorts and chemical apparatus, presided over by the nerves, and through the vito-electric, or nerve-fluid, made to assume just such shapes and sizes as may be necessary, or as this vital chemistry may require for the production of the peculiar substance of the particular part acting.

The chemist regulates his apparatus, his retorts, tubes, spirit-lamps, substances to be acted upon in the requisite position, having the proper consistency, etc., and then stops, withdraws his influence, but the chemical actions and reactions go on, new substances are produced without his assistance or influence: so I conceive the nerve of a part may have acted to regulate the capillaries, produce the afflux of blood, the presence of oxygen, etc.; and then the experimenter may divide that nerve, withdraw its

* Paper on Cholera: its Phenomena, Causes, etc., published in the Transactions of the Medical Association of the Eastern District of Brooklyn, for October, 1865.

influence, and yet the nutrition of the part will go on for a time without such nervous influence; but this, in the one case, does not prove that the process of nutrition can continue uninterruptedly and normally without the nerves and nervous influence, any more than in the other; it is proved that the products of a chemical manufactory can be continually produced without the influence of the mind and hands of the chemist. Dr. Brown-Séquard further says:

"Not only can an excitation of the same nerve produce effects in the different parts of the nervous centres, in one or other of the viscera, or in distant nerves, or muscles, or bones, etc., but it can also produce, in the same part of the nervous centres, in the same viscus, in the same muscle, etc., different kinds of alteration. Why is there such a variety of alterations produced in one and the same part by an excitation which varies only in intensity? To answer this question I must go beyond the limits of the subject-matter of this course of lectures, and cast a glance on the mode of production of morbid affections of the various tissues and organs. Physiology, morbid anatomy, and clinical observation, clearly point out that all nervous affections (organic and functional), as well as affections of any other part of the body, owe their production to three different causes.

"1st. A special inherent tendency (inherited or not) of the elementary parts of the tissues to become altered in one or in another way.

2d. The production or introduction in the blood of those materials that are necessary for the formation of morbid growths, or able, like poisons, to cause alterations of nutrition or secretion.

"3d. An influence of an excitation from outside, acting with or without the intervention of the nervous system, or a purely nervous influence starting from a peripheric or a central part of the nervous system.

"If we keep in mind the truth that these three causes may exist together and in various degrees, we can easily understand how the same excitation of the same nerve may produce in the same distant part different kinds of alteration of nutrition. It is so that an irritation from a wounded nerve will produce either tetanus, or cholera, or catalepsy, or epilepsy, or delirium, etc., and, by a reflex action on a peripheric part, muscular wasting or trembling, a contracture, a neuralgia, etc."

I deem it also possible, and highly probable, that the minute or

microscopic anatomy of the animal economy is not yet completely developed. As with the improved telescope, the modern astronomer has been able to discover stars far beyond the point that his learned and wise predecessor dared to dream of, so may the microscopist, when his instrument is further improved, discover new truths in anatomy and physiology. I expect the vital process will yet be made much plainer than now; I expect the capillary action, or perhaps the action of vessels or glands,* more minute than the capillary vessels, will yet be better understood; I expect the time will come when the physician, who sees a derangement of nutrition or secretion, such as *tubercle* or *cancer*, will know what set of nerves or nervous filaments is diseased or deranged, and what cluster of vessels or glands are producing this morbid matter; or, in other words, that he will be able to discover the whys and wherefores of these derangements of the vital chemistry.

NOTE B.

When I contemplate what a great change has taken place during the past fifteen years in the treatment of inflammatory diseases, and in the opinions of physicians as to the nature and action of "*antiphlogistics*," I am more than surprised—I am *astonished*.

What would Prof. Alonzo Clark have thought fifteen to twenty years ago if called in consultation, to see a patient in all the agonies of acute rheumatism with cardiac complication, and found the attending physician only giving sup. carb. soda? with no calomel, no blisters, nor anything of that sort. Even only thirteen years ago, when this chemical theory of inflammation first troubled my poor brain, and when I worked out, purely *as a theory*, that inflammations produced an acidulated condition of the blood of the part inflamed, I had no idea of the real condition of the blood, and particularly of the decided *acid* condition of the perspiration, urine, and other excretions and secretions of a patient suffering from extensive inflammations, as of acute rheumatism. It is but a *few* years since the great work on rheumatism by Dr. Henry Wm. Fuller, of London, has completely

* Prof. Brown-Séquard said in his Lectures at the N. Y. Academy of Medicine, that a former pupil of his had already demonstrated that there is a system of lymphatic glands in the brain.

overturned the medical mind of the world upon this great subject. And now that the medical profession (save, perhaps, some here and there who won't admit that there can be anything known that was not taught to them twenty or thirty years ago) have come, and are coming, to a realization of the fact, that an acid condition is developed during an inflammatory state; the danger is, that too much confidence will be placed in these alkalies—the cause of the disease will all be lost in contemplating the effect. We should not, as it seems to me, forget that this acid condition is only the result of an abnormal action of the vital chemistry, and of the influences which control this action. Dr. Fuller is fully aware of this, and forcibly says in his work on rheumatism, page 112, when speaking of the astonishing relief afforded by alkalies: "Administered alone, however, and in ordinary doses, they are inadequate to effect a speedy cure. The system is so surcharged with acid, that no ordinary doses can restore its alkalinity; and even when given in doses sufficient to effect this purpose, alkalies in many cases prove unequal to restore a healthy state of assimilation, and to prevent the further formation of acid in the system. Of this, I am fully satisfied by experience. The pain may be greatly alleviated, and the force of the febrile and inflammatory symptoms checked, but no certainty can be felt as to arresting the disease without the aid of other medicines to *assist in modifying the function of assimilation*, and to act on the various excretory organs."

NOTE C.

Vital action, vito-chemical action, vital chemistry, and such like, are phrases which I have been in the habit of using since my first *début* in the medical profession, and terms for which I have suffered considerable ridicule, particularly from some such members of the profession as always are very cautious not to say or do or *think* anything that has not been said or done or thought by some author or professor. My only excuse has been that these phrases have expressed my meaning the best of any that I could use, and I find nowadays that they are not at all uncommon phrases.

Dr. Walter F. Atlee, of Philadelphia, in his Notes on "Bernard and Robin, on the Blood," page 223, after carefully describing the very interesting experiments of M. Bernard, in which he divides different nerves and nerve-fibres, and thereby increases or decreases

the heat or vascularity of a part at will, records him as saying, to sum up: "I have only wished in this work to establish one point in the very complex history of the sympathetic, to wit: that the section of the filaments or of the ganglions belonging to this nerve, has constantly the privilege of augmenting the calorification of the parts to which it is distributed."

"These phenomena of calorification, which are produced by acting on the sympathetic, are in reality only the exaggeration of those that take place in the production of animal heat. In giving the means of increasing the calorific acts, and of localizing them in exterior parts, easy to observe, I have had the thought of rendering more accessible to our means of investigation the study of this important function, still so little known, but which could not be sought elsewhere than in the greater or less activity of the *chemical metamorphosis, which the blood undergoes in the living tissues under the special influence of the nervous system.*"

It seems to me inappropriate, in referring to the *vital phenomena*, to use the terms chemical action, chemical affinity, etc., without a qualifying word, so as clearly to distinguish and set forth the fact, that these phenomena, when taking place in the animal economy under the influence of the vital forces, are quite a different matter from the chemical processes taking place in inorganic bodies. It has been truly said by Prof. John C. Dalton, of the College of Phys. & Surg., in his work on Physiology, etc., page 54, "We must *not* attempt to deduce the chemical phenomena of physiology from any previously established facts, since these are no safe guide; but must study them by themselves, and depend for our knowledge of them upon direct observation alone."

Dr. Dalton says again: "Many of the phenomena of life are chemical in their character, and it is requisite, therefore, that the physiologist know the ordinary chemical properties of the substances composing the animal frame. But no amount of previous chemical knowledge will enable him to foretell the reactions of any chemical substance in the interior of the body, because the peculiar conditions under which it is there placed, modify these reactions, as an elevation or depression of temperature, or other external circumstances, might modify them outside the body."

Again: "A very large and important class of the vital phenomena are those of a chemical character. It is one of the characteristics of living bodies that a succession of chemical actions, combinations,

and decompositions, is constantly going on in their interior. It is one of the necessary conditions of the existence of every animal and every vegetable, that it should constantly absorb various substances from without, which undergo different chemical alterations in its interior, and are finally discharged from it under other forms. If these changes be prevented from taking place, life is immediately extinguished. Thus, animals constantly absorb, on the one hand, water, oxygen, salts, albumen, oil, sugar, etc., and give up, on the other hand, to the surrounding media, carbonic acid, water, ammonia, urea, and the like; while between these two extreme points of absorption and exhalation, there take place a multitude of different transformations, which are essential to the continuance of life.

"Some of these chemical actions are the same with those which are seen outside the body; but most of them are entirely peculiar, and do not take place, and cannot be made to take place anywhere else. This is not because there is anything particularly mysterious or extraordinary in their *nature*, but because the conditions necessary for their accomplishment exist in the body, and do not exist elsewhere. All chemical phenomena are liable to be modified by surrounding conditions. Many reactions, for example, which will take place at a high temperature, will not take place at a low temperature, and *vice versâ*. Some will take place in the light, but not in the dark; others will take place in the dark, but not in the light. * * * * The chemical conditions of the living body are exceedingly complicated. In the animal solids and fluids there are many substances mingled together in varying quantities, which modify or interfere with each other's reactions. New substances are constantly entering by absorption, and old ones leaving by exhalation; while the circulating fluids are constantly passing from one part of the body to another, and coming in contact with different organs of different texture and composition. All these conditions are peculiar, and so modify the chemical actions taking place in the body, that they are unlike those met with anywhere else. * * * * The chemical phenomena of the living body are, therefore, not different in their nature from any other chemical phenomena, but they are different in their conditions and in their results, and are, consequently, peculiar and characteristic. * * * * A troublesome confusion might arise if we were to neglect the distinction that exists really between these different sets of phenomena, and confound them together under the expectation of thereby simplifying our studies."

"Since this can only be done by overlooking real points of difference, its effect will merely be to introduce erroneous ideas, and suggest unfounded similarities, and will, therefore, inevitably retard our progress instead of advancing it."

NOTE D.

The use of opium in inflammations was at no distant day thought to be wholly contra-indicated; and it was given, if given at all, with very great caution, and only ventured upon occasionally when the patient was very greatly suffering pain; it was said to produce *congestion* of the part, and was thought to be (and there are yet some of the same opinion, I believe) very dangerous, particularly in inflammations of the brain or its meninges, or of the lungs. Who at this day does not remember how the whole profession held their breath in astonishment, when Prof. A. Clark first suggested the idea and put it into practice, of depending upon opium as *the remedy* in puerperal peritonitis!

The late Prof. C. R. Gilman used to relate his horrible dreams of poisoned patients and coroners' inquests when he first ventured to use the remedy; but now, opium, in connection with other assisting remedies, particularly veratrum viride, is looked upon as *the great dependence* in this dreaded malady, and the result is a very great improvement in the rate of mortality from this disease. In the discussion upon *pneumonia*, some months since, in the N. Y. Academy of Medicine, I expressed the opinion that the disease (pneumonia) might actually be controlled, *cured*, in its first stage, even after the development of the characteristic crepitant râle, by the use of opium and tartrate of antimony. In that discussion I simply *stated* the fact—and I call it a fact, after positive demonstration in practice; *now*, if the reader understands my theory of inflammation, he will see what would be my course of reasoning to justify myself in such practice. I will just state here, that in the year 1858 I was called to see a lady with pain in side, following a chill, short troublesome cough, quick pulse, hurried and difficult respiration, with crepitant râle on auscultation, and every symptom of an acute attack of pneumonia. I prescribed sulphate of morphia, two grains, and antim. et potas. tart., two grains, syr., half an ounce, water, one ounce; the patient to take a teaspoonful every two hours, and have hot fomentations applied to chest. Called again

in about eight hours, and found the patient had vomited freely, and was asleep; she aroused easily, said her pain was all gone, and that the only inconvenience was that she felt very sleepy and very sick at the stomach. I ordered to discontinue the medicine, except to give it cautiously once in four or five hours if the pain returned; called again about twenty-four hours after the first visit, found the patient very comfortable, and every sign of pneumonia had disappeared, and did not return.

I have used the same means many times since with varying success, resulting, I think, from various causes. If the remedy be given during the first few hours of the inflammation, before much effusion has taken place, if carried to the extent above indicated, it will usually succeed; if too much time has been lost, and the effusions are considerable, it will do good, but further treatment will be necessary to quell the irritation consequent upon the effusions, and to assist the *vis medicatrix naturæ* in *removing* the effusion, as well as to correct and repair the damage done to the part, and restore the natural action thereof. If the remedy be carried to such an extent as to completely overpower the system—paralyse the capillaries, if you please—much harm may be done, and even *death* may be the result; a condition of passive congestion will set in. And, again, in the typhoid or congestive type of the disease, opium, antimony, verat. viride, etc., should be used with great caution, and generally not at all.

But a resort should be had at once to stimulants; not too much ammonia in any form, as the blood is already too inert and watery, but alcoholic stimulants, quinine, capsicum, sulphuric acid, and such remedies as will act to give power and tone to the capillary blood-vessels.

NOTE E.

Passive congestion I conceive to be a partial, or more or less complete, according to its extent and intensity, arrest of the process of nutrition, and a condition exactly the opposite to inflammation.

The collapse of cholera,* or of any other disease, seems to be a

* See Paper on Cholera, in Transactions of Medical Association of the Eastern District of Brooklyn, for October, 1865, page 31.

general paralysis of the capillary system; the nervous influence, which should conduct and control the vital chemistry of the person, seems to be overpowered and withdrawn; hence the contractile force of the capillaries is lost, and these vessels fill up like veins, and, of course, death ensues. Hence the propriety in all such conditions of endeavoring to rid the system, so far as possible, from whatever poison has produced this state; and of endeavoring by all possible means to produce a reaction of the nervous force, and to make use of whatever remedy will seem to act most directly upon the contractile and vivifying power of the capillaries; hence the poisonous nature of opium in the collapsing cholera patient; hence, also, the power of counter-irritants in the same malady. Stimulating and astringent injections may be, and have been useful, if given, not simply to control diarrhœa, but with a view of producing a reaction in the capillaries. In the *early* stage of cholerine, and kindred diseases, before the power of the poison has utterly prostrated the nervous system, opium, given moderately, has, no doubt, a beneficial effect, as it steadies and supports the flagging energies of the system, and thus has, I am confident, *many* times saved life which would otherwise have succumbed to a cholera attack. Camphor, capsicum, sulphuric acid, etc., are remedies of great value in congestive diseases, for the reason that their action seems to be to give power and tone to the capillaries.